Uncertainty Related to Geophysical Sampling

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LONG TERM GOALS

The goals of this research are to define and characterize the variabilities and uncertainties in the components and linkages of the general physical-geo-acoustical system (the *System*) relevant to the support of naval operations, and transfer quantitatively the spatial-temporal environmental variabilities and uncertainties through the System, including coupled interactions, in order to determine uncertainty measures, sensitivities and feedbacks critical for operational predictions and parameters.

OBJECTIVES

Transfer uncertainties from the acoustic environment to the sonar and its signal processing, in order to effectively characterize sonar performance and predictions. Construct, calibrate and evaluate uncertainty and variability models, for the System and its components, to address forward and backward transfer of uncertainties based upon the process of end-to-end data assimilation. Develop generic methods for efficiently and simply characterizing, parameterizing, and prioritizing System variabilities and uncertainties arising from regional scales and processes.

APPROACH

The nature of the horizontal and vertical distribution of the bottom and sub-bottom scales and attributes (attenuation, velocity, density) will also be evaluated using acoustic data, ancillary data (including but not limited to in situ samples, seismic) and stochastic models relating the variable of the various components to observable features. The uncertainty in acoustic prediction will be initially viewed in terms of the mean error in acoustic prediction caused by the using the i^{th} geoacoustic model as the input geoacoustic model in each of the other source sites. The variations in geoacoustic models will be correlated with the variations in ancillary data to determine the degree to which surface observables can be used to cue sampling strategies.

The areal variation in scattering strength will be investigated by inverting for scattering strength at each of a number of source locations. From the inversion for geoacoustic parameters we will have an estimate of the source beam pattern, and a geoacoustic model. Using these as input we can invert for bottom scattering strength as a function of grazing angle, and as function of location. We can then estimate the uncertainty in reverberation prediction (a system function) in the exercise area.

The resulting statistical parameters will be used to quantify sonar processing performance (signal and reverberation).The *System* Probability Density Function (PDF), a probabilistic description of the environment's intrinsic variability, measurement uncertainty, and impact on the sonar's signal-to-

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14. ABSTRACT
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interference ratio, will be developed for fleet applications. These PDFs will be assessed as to their impact on signal processing, including detection and estimation (bearing, range, depth, etc.).

WORK COMPLETED

The surficial geology, and shallow subsurface geology of the ACT III site A (see Fugua(1996) for acoustic geometries) were determined from a combination of in situ measurements, and published material. From the geology and geophysics data we constructed base geoacoustic models to use as both starting fields for inversion processes, and zeroth order comparison. Figure 1 show a summary of the in situ measurements made during the exercise, and the acoustic data that were selected for inversion.

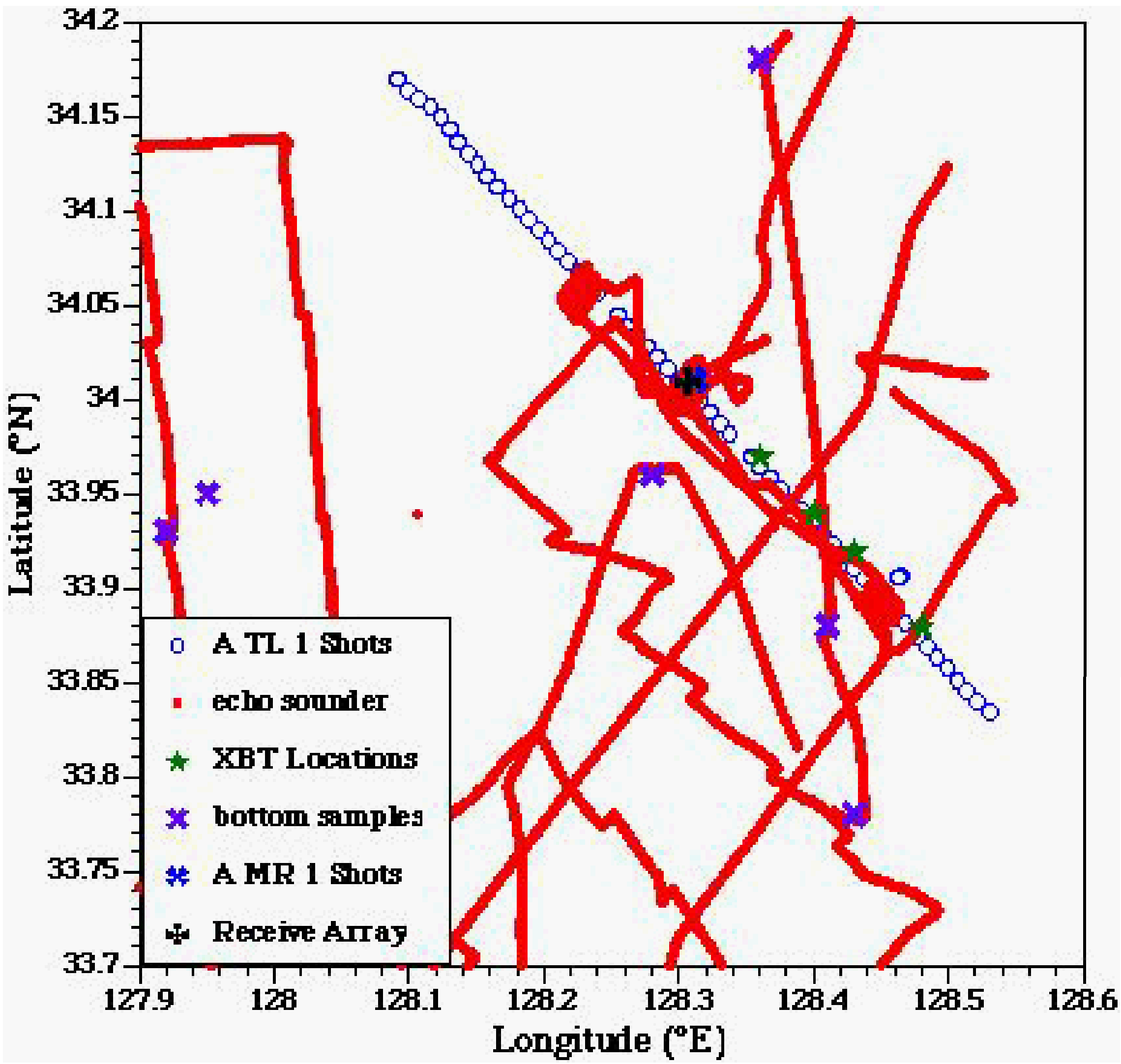

Figure 1. Plot of ACT III site showing location of omni directional shots (circles, and diagonally crossed goblets), echo sounder track (line formed from squares), XBT locations during Leg 2 of A-TL-1 (stars), DART receiver array (maltese cross), and bottom samples (X's).

ADCP bathymetry data were merged with DBDB-V to construct a base bathymetry for the exercise. Since each leg of the exercise took place in a compact zone spatially and temporally the sound speed field for the data was derived from the nearest measurement.

We inverted TL data for geoacoustic environment from CW sources at 5 frequencies (47, 83, 111, 354, 604) using a simulated annealing method with FEPE as the propagator. The inversion was done simultaneously at all frequencies to insure that 'best solution' to all frequencies. Time series (50 Hz to 800 Hz) for single hydrophones were inverted for geoacoustic environment using small omni-directional sus charges as sources by synthesizing the time series using FEPE, and by calculating the time series via the method of Gaussian packets. For the inversion using CW sources at criterion of average absolute error of 3 dB was used, while for the time series a similar a multiplicative factor of two for the average absolute error was used although the errors are not strictly comparable.

Scattering strength versus grazing angle were computed for one monostatic event (a shot from A-MR-1), and one bistatic event (a shot from A-Tl-1). The effort in inverting scattering strength to date reflects a proof of concept for the inversion technique because the sample is too small to be significant.

RESULTS

The results of the geoacoustic inversion models are consistent among themselves, that is the predictions using the geoacoustic models in FEPE for the CW sources agree to less than 2 dB average absolute mean error. Analysis of the geoacoustic models and surface sedimentary geology (KORDI) personal communication, and Bucca et al (1997)) revealed areas of both strong and weak correlation between the surficial material. The strong areas of correlation occur in areas dominated by relic materials from the Pleistocene period (Park and Lee (1994), Park and Song (1971)), while weaker correlations occur where modern fine grain sediments overlay the relic material. Echo sounding data, grab samples, and cores all suggest that modern veneer is negligible in agreement with the geoacoustic inversions (Lee et al 1990).

IMPACT/APPLICATIONS

None

TRANSITIONS

None

RELATED PROJECTS

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PUBLICATIONS

None

PATENTS

None.